

Preventing Weight Gain in Adults: The Pound of Prevention Study

ABSTRACT

Objectives. This study examined whether weight gain with age could be prevented through the use of a low-intensity intervention.

Methods. Participants, 228 men and 998 women recruited from diverse sources, were randomized to one of the following groups: (1) no-contact control, (2) education through monthly newsletters, or (3) education plus incentives for participation. All participants were weighed and completed questionnaires about behaviors and attitudes related to weight at baseline and annually for 3 years thereafter.

Results. Individuals in intervention groups reported favorable changes over time in frequency of weighing and healthy dieting practices relative to those in the control group. These behavior changes were in turn related to a reduced rate of weight gain over time. However, weight gain over 3 years did not differ significantly by treatment group.

Conclusions. This low-intensity educational approach to weight gain prevention sustained interest over a lengthy time period and was associated positively with behavior change, but it was not strong enough to significantly reduce weight gain with age. (*Am J Public Health*. 1999;89:747-751)

Robert W. Jeffery, PhD, and Simone A. French, PhD

Obesity has attracted increasing concern in recent years as a public health issue because it is causally related to a variety of negative health outcomes, including diabetes,¹ hypertension,² cardiovascular disease,³ and some cancers,⁴ and its prevalence in the United States has risen dramatically in the last decade.⁵ The magnitude of the problem of obesity is further underscored by the fact that extensive research has not yet produced practical and effective long-term treatments for the disorder once it has developed.⁶

Bleak prospects for successful medical management of obesity suggest that an approach to the problem that focuses on primary prevention rather than treatment may be more effective. From a population perspective, obesity is primarily an adult-onset disorder. Between the ages of 20 and 50 years, average weight gain per year among adults in the United States is approximately 0.5 to 1 kg.⁷ Slowing this rate of weight gain would be an important step in reducing the population impact of obesity. However, methods for accomplishing this objective have, to date, received little research attention.

Only one published study has specifically evaluated a program for weight gain prevention. Forster and colleagues conducted a 1-year weight gain prevention trial with normal-weight adults.⁸ In this study, an intervention involving low-intensity education with financial incentives for maintaining body weight produced an average weight loss of 1 kg, which differed significantly from the 0-kg weight change observed in an untreated control group.

The present article reports the results of a 3-year weight gain prevention trial that was an extension of this earlier work. A large and diverse sample of adults participated in the study, half receiving low-intensity educational interventions and the other half receiving no treatment. This report describes participation in the intervention and the effects of the intervention on weight-related behaviors and body weight.

Methods

Setting

The Pound of Prevention study was conducted in collaboration with 4 local health departments serving individuals in the cities of Minneapolis and St. Paul, Minn, and 2 adjacent suburbs. Study participants were assessed at 1 of 3 health department sites or a university site annually for 3 years. Intervention activities were conducted by mail and through face-to-face education at health department sites and other community settings.

Participants

Study participants were recruited from a variety of sources. Two hundred twenty-eight men and 594 women were recruited by direct phone solicitation, newspaper advertisements, and mailings to employees of a large educational institution (the University of Minnesota). Because obesity and weight gain with age are particularly problematic for women of low socioeconomic status (SES),⁹ 404 low-income women (household incomes of \$25 000 or less per year) were recruited via telephone solicitations in neighborhoods with a high concentration of low-SES households, information booths at shopping centers in low-income neighborhoods, and face-to-face recruitment of women participating in the Special Supplemental Nutrition Program for Women, Infants, and Children.

To be eligible for the study, participants had to be (1) aged 20 to 45 years, (2) not cur-

The authors are with the Division of Epidemiology, School of Public Health, University of Minnesota, Minneapolis.

Requests for reprints should be sent to Robert W. Jeffery, PhD, Division of Epidemiology, University of Minnesota, School of Public Health, 1300 S Second St, Minneapolis, MN 55454-1015.

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rently pregnant and not pregnant in the previous 12 months, (3) free of serious medical or psychological conditions requiring treatment, and (4) willing to participate in the project for 3 years. Body weight was not used as an entry criterion because the rate of weight gain with age is higher in young adults who are already overweight than in those of normal weight.⁷ Thus, weight gain prevention is equally important for this group.

Design

Following the baseline assessment, half of the study participants were randomized to a control condition and the remainder to one of 2 intervention conditions (described subsequently). Participants' weight and weight-related behaviors were evaluated annually for 3 years following randomization. The primary hypothesis evaluated in the study was that individuals assigned to the intervention groups would gain weight at a lower rate than those assigned to the control group. The study was reviewed and approved by the Institutional Review Board of the University of Minnesota.

Intervention

The educational intervention for individuals in both Pound of Prevention intervention groups encouraged paying attention to weight and making small changes in diet and exercise habits. Education messages emphasized 5 major themes: (1) weighing oneself regularly (at least once a week), (2) eating more fruit (2 servings per day), (3) eating more vegetables (3 servings per day), (4) reducing consumption of high-fat foods, and (5) increasing exercise, with a particular emphasis on walking. Reduction in energy intake was not specifically recommended. The primary vehicle for delivering education messages was a monthly newsletter, 2 to 4 pages in length, that focused on one of the program messages and included practical guides for behavior (e.g., recipes and locations in the community for walking or other types of physical activity). A return-addressed, stamped postcard was included in each newsletter. Study participants were asked to answer 5 questions printed on the card and to return it. Participants were asked whether they had, in the last 24 hours, (1) walked for 20 minutes or more, (2) eaten 2 fruits, (3) eaten 3 vegetables, and (4) weighed themselves; they were also asked to report their current weight.

Once every 6 months, intervention participants were offered the opportunity to participate in additional low-cost intervention activities. Activities offered during the 3

years of the study included the following: (1) 4-session weight control classes staffed by nutritionists at local health departments, (2) educational seminars on physical activity, (3) aerobics dance, (4) a free membership for 1 month to a community exercise facility, (5) a walking group, (6) a mail-based weight loss course, and (7) a home-based walking competition. These activities have been described in greater detail elsewhere.¹⁰

The only difference between the 2 treatment conditions (education only and education plus incentive) was that a \$100 lottery drawing was held each month for members of the incentive condition who returned their monthly newsletter postcards. The intent of the incentive lottery was to encourage participants to open and read their newsletters and thus to learn more about weight gain prevention.

Measures

Information about participant characteristics, weight-related behaviors, and body weight was obtained at each of the annual study visits. Data used in the present report included the following.

Demographics. Information on the following demographic characteristics was gathered: (1) age in years, (2) current marital status (married vs other), (3) educational level (high school or less, some college, college degree or more), and (4) ethnicity (White vs other).

Participant type. Participants were categorized into 3 groups based on gender and method of recruitment: (1) high-income women (family income of more than \$25 000 per year), (2) low-income women (family income of \$25 000 per year or less), and (3) men (all of whom were "high income").

Smoking status. Smoking status was defined dichotomously in terms of self-reported current daily smoking (yes vs no).

Body weight. Weight was measured on a calibrated balance beam scale (with participants in light clothing but without shoes).

Height. Height was measured with a wall-mounted ruler.

Body mass index (BMI). BMI was computed as weight in kilograms divided by height in meters squared.

Diet. Usual dietary intake was measured via the 60-item Block Food Frequency Questionnaire.¹¹ The present analyses examined estimates of total energy intake per day in kilocalories and percentage of energy from fat.

Exercise. Physical activity was measured with an instrument adapted from Jacobs et al.¹² in which respondents were asked to report the frequency with which they engaged in 13 exercise activities. An exercise score was calculated as frequency per week

of each activity multiplied by intensity level (in metabolic equivalents¹³) and summed across the 13 activity items.

Weight control behaviors. Three weight control behaviors are reported. The first was frequency of weighing oneself (per month), assessed with a single question. The second and third were summary measures derived from a 23-item questionnaire assessing whether participants had used any of 23 specific weight control practices in the last year (each item was scored as yes vs no). Two scales were developed on the basis of a factor analysis: a healthy weight control practices score comprising 9 items (reducing calories, increasing exercise, increasing fruit and vegetable intake, decreasing fat intake, cutting out sweets and junk foods, reducing amounts of food, changing type of food, eating less meat, and eating low-calorie diet foods) and an unhealthy weight control practices score comprising 5 items (using laxatives, diuretics, appetite suppressants, diet pills, and liquid diet supplements).

Process measures. For individuals in the 2 intervention conditions, participation in intervention activities was assessed as (1) the proportion of total possible newsletter postcards returned in each year of the study, (2) the portion of participants who reported that they read the newsletter "usually" or "every month" at their last assessment visit, and (3) the proportion of participants who took part in 1 or more additional intervention activities.

Message recognition. Beginning in year 2 of the study, a questionnaire was administered that asked study participants to indicate the 5 best ways to prevent weight gain. Twenty-one choices were provided, including the 5 primary study messages. This questionnaire was scored in terms of the proportion of the 5 study messages that participants checked.

Statistical Analysis

SAS statistical software was used in conducting all analyses.¹⁴ General linear modeling programs were used to examine the relationship between treatment assignment and study outcomes. One hundred six women became pregnant during the 3 years of observation and were excluded from the analysis. Of the remaining study participants, 809 (72%) completed all 4 data collection visits, and 292 provided partial data beyond baseline. Results presented here describe outcome analyses using only study participants with measured weight at all 4 evaluation visits. Parallel analyses that also included individuals with partial data yielded very similar findings and are not described separately.

Two methods were examined for representing outcome variables (changes in weight and weight-related behaviors). The first was to analyze treatment outcomes separately by year (i.e., weight and behavior changes at years 1, 2, and 3). The second was to compute a rate of change per year in weight and behavioral variables for each individual by regressing the outcome variable (e.g., weight) on time (year).

Based on examination of differences between treatment groups at baseline (described subsequently) and a priori assumptions about factors likely to be associated with weight change over time, the following covariates were included in all analyses: baseline BMI, participant type (men, high-income women, low-income women), smoking status at each year, marital status at each year, and ethnicity. Interactions between treatment and participant type were also examined, but these interactions were not significant and thus were not included in the models reported here.

Results

Baseline Characteristics

Table 1 shows the characteristics of study participants at baseline. Participants averaged about 38 years of age, had a mean BMI of approximately 26 to 27, were about 80% female, and were primarily White. The 3 treatment groups were similar on these variables with 2 exceptions. First, the mean BMI of the education-only group was somewhat higher than that of the other 2 groups. Second, there was a higher percentage of Whites in the 2 education groups (92% and 93%, respectively) than in the control group (87%). Participants with complete data differed from participants with incomplete data on a number of variables. Those with the complete data were older; had lower BMIs, lower reported energy intakes, lower smoking rates, and higher levels of education; and were more likely to be White (all $P < .01$). There was no evidence, however, to suggest differential loss to follow-up as a function of treatment group.

Intervention Participation and Message Recognition

Participation of study subjects in intervention aspects of the study was generally good. Participants returned an average of 68% of newsletter postcards across the 3 years of the study, 80% reported having read most or all of the newsletters when asked at the end of the study, and 25% participated in 1 or more of the extra activities offered periodically. Newsletter readership was slightly

TABLE 1—Baseline Characteristics of Study Participants, by Treatment Group

	Treatment Group			P
	Control	Education + Incentive	Education Only	
No.	414	198	197	...
Mean age, y	38.0	38.5	38.8	.30
Smoking, %	16.0	15.2	18.7	.60
Female, %	81.9	77.7	79.3	.44
Education, %				
High school or less	12	10	10	...
Some college	36	32	35	.79
College or more	52	57	55	...
White, %	87	92	93	.04
Married, %	50	48	49	.81
BMI, kg/m ²	26.5	26.1	27.5	.05
Energy intake, kcal/d	1702	1682	1753	.83
Fat intake, % calories	34.0	34.0	33.9	.97
Mean exercise score	46.6	48.0	42.9	.24
Weighing frequency (per month)	4.8	4.0	5.2	.39
Mean healthy weight loss practices score	3.13	3.17	2.80	.35
Mean unhealthy weight loss practices score	0.14	0.21	0.13	.24

Note. BMI = body mass index.

higher in the education plus incentives group than in the education-only group (71% vs 65%; $P < .05$).

Examination of data from the message recognition test indicated that the intervention was effective in transmitting desired information to study participants. Across the 3 years of the study, participants in the 2 education groups consistently identified 75% of the targeted treatment messages as being among the 5 best ways to prevent weight gain, as compared with 66% of those in the control group (all $P < .001$). Within the education groups, message recognition was also positively related to newsletter readership in follow-up years 2 and 3 (all $P < .01$).

Behavior Changes

Table 2 presents data on reported changes in energy intake, percentage of calories from fat, physical activity, weighing frequency, unhealthy weight loss practices, and healthy weight loss practices by treatment group. There was an overall tendency for participants to report lower levels of all behaviors over time, a tendency that we interpreted as reflecting a fatigue effect of filling out lengthy questionnaires repeatedly. Between-group differences in reported behavior changes, however, were consistent with the behavior change objectives of the study, although of modest magnitude. Declines in reported energy and fat intake were generally greater in the 2 treatment groups than in the control group. Reported exercise decreased less in the 2 treatment groups than in the con-

trol group. Differences between treatment groups on these variables were not statistically significant, however. The 2 significant behavioral effects were an increase in reported frequency of weighing in the intervention groups (vs a decrease in controls) and a smaller decrease in the reported frequency of healthy weight loss practices in the intervention than the control groups. Reports of unhealthy weight loss practices declined over time, and the declines did not differ by experimental group.

Behavior Change vs Weight Change

Table 3 presents data on the relationship between change in weight-related behavioral variables and change in body weight over the 3 years of the study. Table entries are unadjusted correlations between changes in behavioral variables and changes in weight observed over 1, 2, and 3 years of the study and between weight and behavior change slopes calculated over all 3 years. Although the correlations were small in magnitude, these data indicate that, in general, changes in behaviors influenced by the intervention were related to changes in body weight in the expected way. Change in reported energy intake over time was positively associated with weight change, and changes in reported exercise, frequency of weighing, and healthy weight loss practices were inversely related to weight change. Change in fat intake was positively associated with weight gain in year 1 and year 2. Changes in unhealthy weight loss practices were unrelated to weight changes.

TABLE 2—Changes From Baseline in Weight-Related Behaviors at Years 1, 2, and 3, by Treatment Group

	Treatment Group			P
	Control, Mean (SEM)	Newsletter, Mean (SEM)	Newsletter + Incentive, Mean (SEM)	
Energy intake, kcal/d				
Year 1	-122 (52)	-198 (76)	-88 (76)	.58
Year 2	-172 (51)	-142 (74)	-158 (74)	.94
Year 3	-130 (54)	-213 (78)	-183 (78)	.66
3-year slope ^a	-44 (17)	-60 (24)	-62 (24)	.79
Fat intake, % of energy				
Year 1	-0.6 (0.4)	-1.8 (0.5)	-1.7 (0.5)	.10
Year 2	-0.7 (0.4)	-1.5 (0.6)	-1.1 (0.6)	.44
Year 3	-1.1 (0.4)	-1.3 (0.6)	-1.4 (0.6)	.84
3-year slope ^a	-0.3 (0.1)	-0.4 (0.2)	-0.4 (0.2)	.91
Exercise (metabolic equivalent units)				
Year 1	-1.2 (1.5)	1.4 (2.2)	-0.3 (2.2)	.61
Year 2	-1.9 (1.4)	0.4 (2.0)	-1.6 (2.0)	.67
Year 3	-4.5 (1.5)	0.9 (2.1)	-2.3 (2.1)	.12
3-year slope	-0.5 (0.5)	0.2 (0.7)	-0.8 (0.7)	.15
Weighing frequency (per month)				
Year 1	-0.9 ^a (0.4)	1.3 ^a (0.6)	1.3 ^b (0.6)	.007
Year 2	-0.2 ^a (0.4)	1.5 ^b (0.6)	1.8 ^b (0.6)	.006
Year 3	-1.0 ^a (0.4)	0.1 ^b (0.6)	1.1 ^{a,b} (0.6)	.01
3-year slope	-0.2 ^a (0.1)	0.1 ^{a,b} (0.2)	0.3 ^b (0.2)	.05
Unhealthy weight loss practices				
Year 1	-0.05 (0.02)	-0.05 (0.04)	-0.12 (0.04)	.23
Year 2	-0.08 (0.02)	-0.06 (0.03)	-0.09 (0.03)	.75
Year 3	-0.08 (0.03)	-0.12 (0.04)	-0.03 (0.04)	.27
3-year slope	-0.02 (0.01)	-0.01 (0.01)	-0.03 (0.01)	.40
Healthy weight loss practices				
Year 1	-0.62 (0.14)	-0.20 (0.20)	-0.56 (0.20)	.20
Year 2	-0.47 (0.15)	-0.09 (0.21)	-0.41 (0.21)	.32
Year 3	-1.02 ^a (0.15)	-0.26 ^b (0.21)	-0.65 ^{a,b} (0.21)	.01
3-year slope	-0.30 ^a (0.05)	-0.06 ^b (0.07)	-0.18 ^{a,b} (0.07)	.01

Note. Means with unshared superscripts differed in post hoc analyses ($P < .05$).

^aBaseline body mass index, participant type (men, high-income women, low-income women), smoking status at each year, marital status at each year, and ethnicity were controlled.

^bChange in weight per year, calculated by regressing weight on year for each participant and averaging across participants.

Weight Gain

The overall mean weight change observed in this study population over a period of 3 years was 1.7 kg (0.5 kg per year). Thirty-seven percent of study participants maintained or lost weight, and 63% gained weight. Observed weight changes spanned a wide range, however (-45.2 kg to +29.8 kg), and the weight change standard deviation was large (6.5 kg at 3 years).

Table 4 presents data on the relationship between treatment group and weight gain. Despite some positive effects of the intervention on behaviors associated with weight change over time, weight change itself was not significantly affected. Point estimates for weight gain were slightly lower in both intervention groups than in the control group at each year, as was the rate of gain across all 3 years. However,

these differences fell far short of statistical significance.

Discussion

This article has reported the results of the first large trial designed to specifically address the question of how to intervene to reduce weight gain with age in the general population. The intervention was educational in nature and low in intensity, an approach shown to have some promise in preliminary studies and also one that recognizes that broad public health measures must necessarily be of low unit cost to be feasible. The primary finding of the study was that differences in weight gain between treated and untreated groups were in the desired direction but not statistically significant. In that this study was the first of its kind, however, much was learned,

and interesting suggestions for further research emerged.

Intervention effects observed in this study were smaller than those observed in prior pilot work,⁸ approximately 0.2 kg vs 0.9 kg at 1 year. Also, observed variability in weight change was larger, and thus the present study had less power than the design had intended (i.e., we expected to be able to detect a 0.7-kg difference between treatment groups at 3 years, but in fact we had enough power only to detect 1.4-kg differences). We believe that differences in both population and intervention methods contributed.

Pilot work was done with a group of highly select, upper SES volunteers with a mean age of 46 years. The present sample was younger and considerably more heterogeneous (e.g., 400 low-income women were included). In addition, the pilot study involved a relatively strong incentive manipulation focused specifically on weight gain (i.e., subjects made a \$120 commitment of their own money over 1 year and were at risk of losing it if they gained weight). The present study used either no incentive (newsletter group) or a \$100 lottery incentive (newsletter plus incentive group) with a roughly 1 in 10 chance of winning over a 3-year period. This incentive was based on return of newsletter postcards, not on weight change, and did not involve study participants' own money.

Differences in population were intentional; we wanted to evaluate the intervention in a heterogeneous population. Differences in the incentive manipulation were dictated by the belief that the larger deposit contract used in the pilot study would discourage participation and, thus, limit the generalizability of the findings. To the extent that the weaker result seen in this study than in the pilot work is attributable to differences in the incentive manipulation, these findings are consistent with research on ways to increase motivation in obesity treatment. Deposit contracts using participants' own money have been shown to motivate weight loss,¹⁵ but monetary incentives using investigator funds have not.¹⁶

Although the present study was not successful in achieving its primary objective, we believe that several aspects of the results are informative for future research in this important area. We found that newsletter mailings are a cost-effective way of communicating with free-living populations over extended time periods (approximately \$10 per person per year in printing and mailing costs). We believe that favorable trends in weight-related behaviors in the intervention groups (e.g., healthy dieting practices, exercise, and frequency of weighing) and the fact that changes in these behaviors were associated with reduced weight gain are encouraging

TABLE 3—Correlations Between Weight Change and Behavior Changes at Years 1, 2, and 3

	Year			3-Year Slope
	1	2	3	
Energy intake	0.09**	0.09**	0.10**	0.08*
Fat intake	0.08*	0.13**	0.03	0.03
Exercise	-0.13**	-0.15**	-0.13**	-0.16**
Weighing frequency	-0.16**	-0.15**	-0.11**	-0.11**
Unhealthy dieting practices	0.02	0.05	0.04	0.06
Healthy dieting practices	-0.09**	-0.05	-0.08*	-0.06

* $P < 0.05$; ** $P < 0.01$.**TABLE 4—Weight Change Over 3 Years, by Treatment Group**

	Treatment Group			P
	Control, Mean (SEM)	Newsletter, Mean (SEM)	Newsletter + Incentive, Mean (SEM)	
Year 1, kg	0.6 (0.2)	0.5 (0.3)	0.4 (0.3)	.75
Year 2, kg	1.4 (0.3)	1.3 (0.4)	1.2 (0.4)	.93
Year 3, kg	1.8 (0.3)	1.6 (0.5)	1.5 (0.5)	.80
3-year slope, lb/y	0.6 (0.1)	0.6 (0.2)	0.5 (0.2)	.88

Note. In calculations of means, baseline body mass index, participant type (men, high-income women, low-income women), smoking status at each year, marital status at each year, and ethnicity were controlled.

and suggestive of ways to improve intervention impact in the future. We also believe that the fact that individuals who were encouraged to be more concerned about their weight did not increase unhealthy weight loss practices is noteworthy in light of prevailing concerns that encouragement of weight control by health professionals may contribute to the development of eating disorders.¹⁷

Suggestions for future weight gain prevention research relate to both intervention format and content. As noted earlier, the use of mail to deliver the intervention was quite successful in this study in that participants reported reading their newsletters over a long period of time. Additional attention might be given to ways in which this delivery format could be made even more effective, however, such as by increasing the frequency of messages, making the intervention more interactive, and tailoring the information provided to participants more specifically to their individual needs (e.g., tailored instruction for people who experience significant weight gain).

Also, intervention messages for weight gain prevention may deserve more thought. Those used in this study emphasized greater attention to weight (the most successful message vis-à-vis behavior change) and modest eating and exercise goals. Interestingly, however, all of the study participants (even the

controls) seemed to have a general awareness of these messages (i.e., 66% of intervention messages were endorsed as among the 5 best ways to prevent weight gain by the control group). Whether more targeted messages about eating (e.g., quantity reduction or change in consumption of specific food items) and exercise (e.g., intensity, type, and duration) and ways to respond to observed weight gains might be more effective is worth exploring. A continuing challenge for all behavior change interventions, whether prevention or treatment focused, is to better address motivational issues. It is easier to teach people what to do than to persuade them to actually do it.

In summary, this study showed that a low-cost, mail-based intervention for weight gain prevention was effective in maintaining the interest of a heterogeneous population of adults over 3 years and that it resulted in modest changes in some reported behaviors. The overall impact on weight itself, however, was very weak, indicating that stronger educational strategies are needed or, alternatively, that education alone is insufficient to deal effectively with this important problem. □

Contributors

R. W. Jeffery designed the study, analyzed the data, and wrote the paper. S. A. French had primary daily

responsibility for implementing the project during its 4 years of operation and provided advice about analysis and presentation issues.

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